

Abstract Submitted
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Why Twist?¹ PROMODE R. BANDYOPADHYAY, DAVID N. BEAL,
Naval Undersea Warfare Center, Newport, RI — Free swimming and flying animals twist their wings. But why? We have carried out force and efficiency measurements with twistable finite fins in water. Twist increases the hydrodynamic efficiency of a rolling and pitching fin, but only up to 5%. Animals tend to operate in narrow frequency ranges of flapping oscillation and amplitude. In such kinematic constraint, twist can increase thrust forces by 20%—a large range, while Strouhal number is held constant (frequency, tow speed and roll angle are held constant) and maximum efficiency is retained. Less than 5% of the roll power is spent in twist to produce this variation in thrust force. Therefore, while our biorobotic underwater vehicles have so far used the square of frequency for thrust control, animals that have resonant design could use twist for control of both cruise and maneuvering. The angle of attack along the span becomes more uniform with twist, becoming the most uniform at 20 degrees. We propose that twist is a method for controlling the direction of the induced flow jetting out of the closed stall vortex that is shed from the fin.

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